7 References

[1] A probabilistic bundle relay strategy in a two hop vehicular delay tolerant network, IEEE Paper, Authors: Maurice J Khabbaz, Wissam F Fawaz, Chadi Assi.

[2] Disruption Tolerant Networking: A comprehensive survey on recent developments and persisting challenges, IEEE Paper, authors: Maurice J Khabbaz, Chadi M Assi, Wissam F Fawaz.

[3] Wikipedia : http://en.wikipedia.org/wiki/Deep_Space_Network

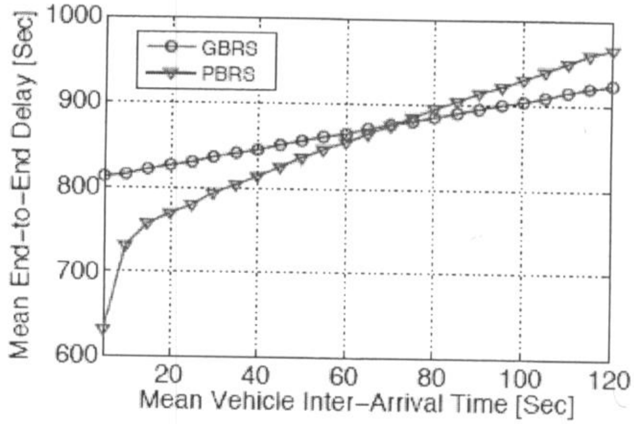


Figure 6 Mean End to End delay of PBRS and GBRS Ref ?

In GBRS, under light loads the queue is emptied quickly so when a fast arriving vehicle pas by, the queue is already empty. On the contrary, in PBRS the bundles are delayed until the b relay opportunity arrives. Under heavier loads, the opposite is true. Therefore at lower values inter arrival times the GBRS has larger end to end delay as compared to PBRS where as at high values PBRS has higher end to end delay, as the load increases.

5 Conclusion

The student has modeled a Probabilistic Bundle Relay Strategy for a Vehicular Delay tolera network based on M/M/1 process. A new term Bundle relay probability is introduced whi relaxes the need for complete network information. Analytical expressions for bundle servi time and bundle probability are derived and the results are analyzed for the conventional GB model with the derived PBRS Model.

6 Critical Analysis

The student has made some assumptions in his model which need further reasoning and in dep analysis, as they cannot be justified at present. These were also discussed during his propos presentation, these are discussed as follows:

- The student has assumed the vehicle's speed as uniformly distributed where as the int arrival times between the vehicles as exponentially distributed. In practice these two a dependent on each other. This assumption needs to be justified.

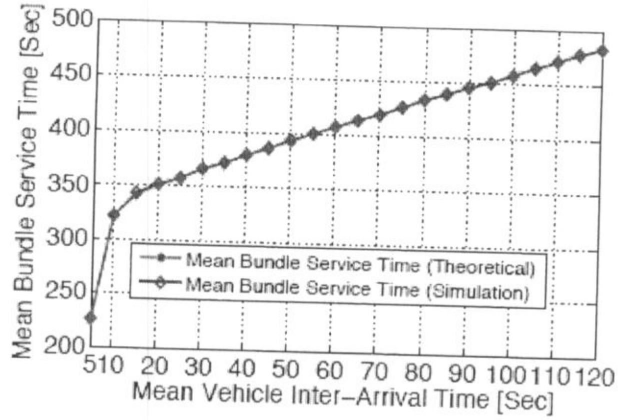


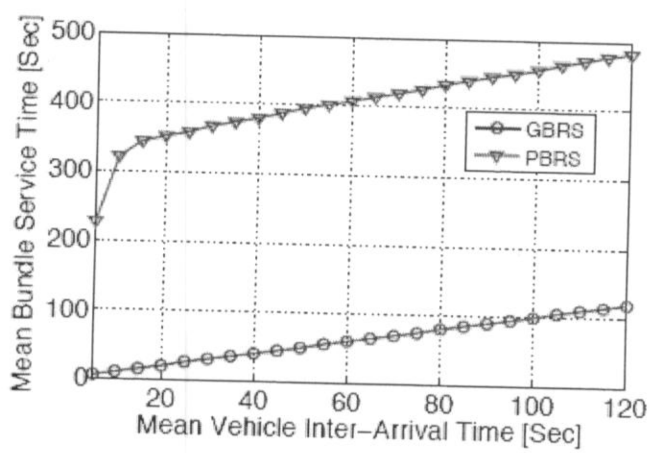
Figure 3 Mean bundle service time as a function of vehicle inter arrival time

Ref Fig

4.2 Comparison of GBRS and PBRS

For the sake of comparison, the student developed a conventional bundle relay strategy, whic called "Greedy Bundle Relaying Strategy" (GBRS), where the source IRS greedily transmi bundle in the queue to every arriving vehicle. The results of the two strategies are compared analysis is presented as follows.

4.2.1 Mean Bundle Service Time



Ref 7

Figure 4 Comparison of bundle service time in PBRS and GBRS

The bundle release probability is given as [1]:

$$P_{br,i} = Pr\left[R \middle| V = v_i\right]$$
$$= 1 - Pr\left[t_{i+1} - t_i + \frac{d_{SD}}{v_{i+1}} < \frac{d_{SD}}{v_i} \middle| V = v_i\right]$$

3.4 Modeling and Analysis of Stationary Traffic sources in VDTNs

3.4.1 Bundle Service Time

The average delay experienced by a head of line bundle in the queue before it is released t passing vehicle.

The student has derived the closed form solutions for the Bundle Release Probability and t Bundle Service time in his thesis proposal using the M/M/1 queuing model for the stationa IRSs (Traffic Sources). The following assumptions were made[1]:

- Bundle transmissions are instantaneous.
- The vehicle's speed remains constant during its entire navigation period on the road.
- The vehicle's inter arrival times are exponentially distributed (Poisson's distribution) with a mean 1/u and density function: ue^{-ut} , t >0 .
- The speeds of the vehicles are uniformly distributed with a density function $1/V_{max}-V_{min}$
- The bundles inter arrival times are exponentially distributed with a mean 1/□□ar density function □e^-□t .
- Bundle release decisions are made independently from one vehicle to the other.
- The source node relays only one bundle per vehicle.

The results are presented as follows:

The bundle service time is given as:

$$f_T(t) = \mu P_{br} e^{-\mu P_{br} t}, \text{ for } t \geq 0$$

3 Vehicular Networks

3.1 Scenario:

Consider figure 2, which shows a Delay Tolerant Vehicular Network (DTVN), where th Immobile Information Relay Stations (IRSs) are deployed. The three IRSs are beyond t communication range of each other, and only one of them is connected to the Internet and called the "Gateway". This scenario can be thought of as a sparsely populated or a remote ar where there is a lack of network infrastructure due to high deployment costs. Different use requiring connectivity are connected to the source and destination IRS labeled as S and D figure 2. The source IRS in turn transmits its packets to the passing vehicles hoping that they w forward these packets (referred as bundles) to the destination IRS. It is assumed that, the time which the vehicles arrive (inter arrival times) are randomly distributed with Poisson Distribution. The speeds of vehicles are also random, with a uniform distribution. The sour IRS buffers/queues the bundles to be transmitted until a vehicle arrives in its range, it the releases the bundles based on First in First out (FIFO) process.

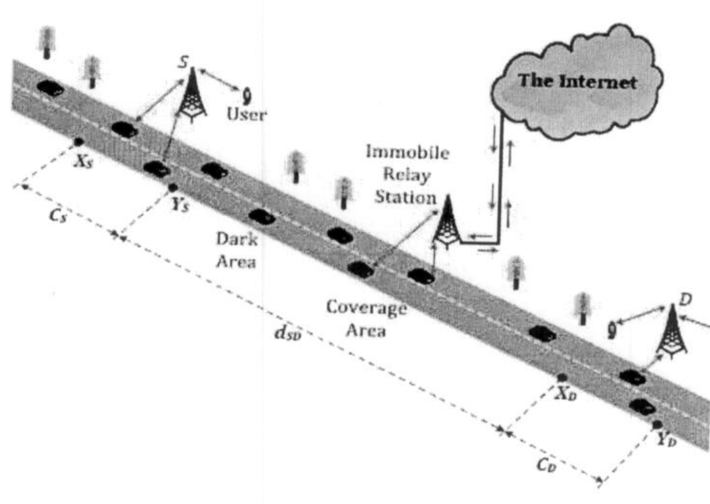


Figure 2 Two hop Vehicular Delay Tolerant Network [1]

2 Introduction

2.1 Intermittently Connected Networks (ICNs):

An Intermittently connected network (ICN) is an emerging class of infrastructure-less wireless network that supports proper functionality of one or several wireless applications operating in stressful environments, where excessive delays and unguaranteed continuous existence of end to end paths between any arbitrary source destination pair, results from highly repetitive link disruptions[2].

2.2 Delay Tolerant Networking:

Delay tolerant networks (DTNs) are very closely connected to ICNs, and that is why the two terms have been used interchangeably in most of the literature. However, in the strict sense of the definition the two terms are different. DTNs are defined as follows:

Delay Tolerant Networking is an overlay architecture intended to operate above the protocol stacks of an ICN and enable gateway functionality between them through the use of a variety of protocol techniques. These techniques include replication and parallel forwarding, forward error correction and many more to overcome communication impairments [2].

For the research proposal under study, the student has used the terms ICNs and DTNs interchangeably.

2.3 Characteristics of ICNs:

- These networks face repetitive and a great number of *link disruptions*.
- There is a high amount of uncertainty with respect to the arriving traffic and the nodes in the network.
- The existing protocols cannot be applied to these networks; the designed protocol has to devise its own operation.
- They are characterized by large delays and many errors; i-e the probability of errors in these networks is very high.

1 Abstract

Disruption/Delay Tolerant Networks (DTNs) are heterogeneous in nature, i-e their opera
requirements vary depending on the network environment, making them suffer from diffe
levels of link disruptions depending on the severity of the operating conditions [1]. Due to
fact, the current networking protocols fail to operate properly in context of DTNs making the
highly active area of research. These networks are also termed as "Intermittently Connec
Networks (ICNs)". The PhD proposal under study particularly focuses on "Vehicular De
Tolerant Networks (VDTNs)", a class of DTNs, assuming the communicating nodes
arbitrarily deployed and can communicate indirectly through the mobile nodes mounted on
vehicles [2]. The objective is to develop a "Probabilistic Bundle Relay Strategy" and "GBR
for a VDTN with partial network information, with minimal delay, based on a queuing model
the VDTN Sources. The simulation results of the two approaches including the bundle deliv
delays and other characteristic parameters are compared [2].

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Seminar Report (ELEC 6961)

(Good Score)

Modeling and Analysis of Road-side communication systems

PhD Proposal by

Fall 2011